# Variability of the data indicating the fertility of different plum varieties

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***Summary:*** Self-fertility and fertility at conditions of open pollination in plum varieties is strictly determined by genetic factors. However, rates of fruit set are highly variable according to growing sites as well as to seasons, which may result from a couple of inner and outer conditions, but mainly from the method applied in seizing the facts of fertility in the experiments planned including the number of replications of treatments. During three successive years, 4–16 trees of each of the four plum varieties have been selected and 16–64 branches were tagged either for checking their fertility as pollinated freely or isolated excluding the access of foreign pollen. The data of fruit set have been processed in order to determine the variability of the data, subsequently, the number of replications necessary to make reliable decisions. Both autogamy and open pollination displayed multiple differences between branches and trees studied.

A number of 20 branches are needed yearly for each variety, the branches should be distributed on 5 trees at least for checking the autogamy, whereas on 10 trees for the results of open pollination. Each variety and treatment should be represented in three seasons, at least because of the different weather conditions.

***Key words:*** plum, self pollination, open pollination

## Introduction

The majority of plum varieties grown extensively are self-fertile (e.g. *Besztercei szilva*). Obviously, those varieties are more reliable in yielding regularly. However, it would be a mistake to exclude varieties of high fruit quality because of their auto-incompatibility, as equally high yields could be achieved in plantations of different varieties associated purposefully and securing cross-fertilisation.

Literature dealing with the fertilisation of European plum varieties settled the question with sufficient precision under Hungarian conditions *(Tóth,* 1975 and 1980, *Szabó & Nyéki,* 2000). As many of the valuable plum varieties are male sterile, auto-incompatible and partially self-fertile, quite a few publications appeared world wide as well as in Hungary dealing with that question. In the first phase, *Tóth* (1957, 1969) checked the autogamy as well as the fruit set of open pollinated flowers on as many as 120 plum varieties. Later a purposeful search for adequate polliniser varieties has been initiated *(Tóth & Erdős,* 1985) and then the variants of the *Besztercei szilva* variety have been explored for their fertility relations *(Tóth* et al., 1988). Correlation between the flower structure and autogamy has been stated by *Surányi* (1985). Our former studies represent the third phase of the investigations in this field. Recently, both extensively grown and new varieties to be introduced were examined and papers appeared on that after 1985. The results have been analysed *(Szabó,* 1989) and the autogamy compared with their fertility with open pollination of 56 further European plum varieties are characterised.

A score of the relevant literature has revealed the high variability of data indicating fruit set, as the number of trees, branches and flowers were also variable as it was adapted always to the local conditions (the size and age of the trees and plantations, work and time available). Descriptions concerning the number of replicates and the position of branches are short and ambiguous. In some cases the number of involved flowers was very low. *Einset* (1939) made less than 100 pollinations for each combination, sometimes between 10 and 20 flowers only. In the classical studies *(Tóth,* 1969; *Iliev,* 1985) each treatment (isolation, cross combination, etc) was yearly observed on several hundred flowers. Some of the observations were repeated through several (3–10) years and some conclusions are based on several thousand flowers.

Results used to be expressed by the ratios of numbers summarised over replications and years. The low number of replicates often excluded the possibility of statistical analysis.

## Material and method

Our experiments have been performed in professionally cultivated, bearing healthy plantations. The applied method of pollination studies was published by *Nyéki* (1974).

Autogamy has been checked on 20–30 cm long branch tips isolated, each by parchment paper bags, which were distributed on the four cardinal points of the crown. Taking 5–10 bags per variety, 100–400 flowers were included. About 3–4 days after bloom, the bags were discarded. In every case the natural autogamy has been registered. Pollen grains fell by gravitation on the own or the neighbouring flower's stigma.

Open pollinated flowers have been observed on 5–10 branches, where 200–500 of them have been counted and labelled also at the four cardinal points of the crown 1.5–2 metres high above the soil level.

Fruit set has been stated and compared about 1–2 weeks earlier than fruit maturity ensued.

At Ráckeve, between 1987 and 1989 four varieties and a high number of replicates on 4–16 trees have been observed. Data were processed according to the mathematical model of *Sváb* (1981) and the critical number of samples necessary for proving the valid differences has been calculated.

$$n = \frac{t^2_{p\%} \cdot s^2}{h^2}, \text{ where}$$

n = number of samples,
$t_{p\%}$ = the value found in the table corresponding to the level of probability,
s = standard error,
h = the allowed error of the estimate.

## Results and discussion

On the basis of data raised by researchers in Hungary as well as in foreign countries *(Tóth,* 1969; *Nyéki,* 1989; *Szabó,* 1989) on different plum varieties, some of them being represented in the same experimental plantations, the conclusion has been allowed that autogamy as well as fruit set after open and cross pollination was utterly variable depending on season and growing site. Our own data *(Table 1)*

***Table 1*** *Autogamy and open pollination in plum varieties*

| Variety | Number of years | Number of growing sites | Autogamy | | | Open pollination | | |
|---|---|---|---|---|---|---|---|---|
| | | | Fruit set (%) | | | Fruit set (%) | | |
| | | | minimum | maximum | mean | minimum | maximum | mean |
| Čačanska najbolja | 7 | 5 | 0 | 0.9 | 0 | 1.1 | 42.7 | 10.5 |
| Čačanska lepotica | 7 | 4 | 0 | 15.5 | 7.4 | 1.9 | 55.1 | 19.9 |
| Čačanska rodna | 7 | 4 | 1.2 | 41.4 | 22.1 | 3.2 | 76.0 | 42.9 |
| Stanley | 8 | 5 | 1.2 | 21.6 | 8.7 | 5.4 | 67.8 | 26.2 |

(Source: Szabó, 1989)

***Table 2*** Fruit set of plum flowers on different branches and trees (Ráckeve, 1987–1989)

| Variety | Year | Fertilisation | Fruit set (%) | Fruit set per branches (%) | | | Fruit set per trees (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of replicates | minimum | maximum | Number of replicates | minimum | maximum |
| Čačanska najbolja | 1987 | open | 7.0 | 64 | 0.0 | 19.6 | 16 | 0.0 | 13.4 |
| | 1988 | open | 8.8 | 64 | 0.0 | 18.4 | 16 | 4.9 | 14.4 |
| | 1989 | open | 35.4 | 60 | 5.7 | 60.0 | 15 | 12.9 | 42.6 |
| Čačanska lepotica | 1987 | selfed | 6.0 | 64 | 0.0 | 20.8 | 16 | 0.0 | 11.6 |
| | | open | 7.0 | 64 | 1.7 | 28.8 | 16 | 4.9 | 21.9 |
| | 1988 | selfed | 1.5 | 48 | 0.0 | 8.1 | 12 | 0.0 | 3.3 |
| | | open | 7.3 | 48 | 0.0 | 17.2 | 12 | 4.4 | 11.5 |
| | 1989 | selfed | 10.2 | 16 | 0.0 | 28.6 | 4 | 7.2 | 11.5 |
| | | open | 15.5 | 16 | 1.6 | 20.5 | 4 | 12.6 | 20.3 |
| Čačanska rodna | 1987 | selfed | 15.1 | 64 | 0.0 | 66.7 | 16 | 5.7 | 28.1 |
| | | open | 37.9 | 64 | 7.7 | 70.3 | 16 | 11.7 | 57.5 |
| | 1988 | selfed | 1.2 | 64 | 0.0 | 9.5 | 16 | 0.0 | 4.8 |
| | | open | 3.2 | 64 | 0.0 | 15.3 | 16 | 0.0 | 8.4 |
| | 1989 | selfed | 35.5 | 63 | 2.3 | 82.4 | 16 | 17.8 | 58.9 |
| | | open | 33.2 | 62 | 5.1 | 69.6 | 16 | 17.0 | 55.2 |
| Stanley | 1988 | selfed | 3.2 | 32 | 0.0 | 18.2 | 8 | 0.0 | 6.8 |
| | | open | 16.5 | 32 | 4.2 | 37.8 | 8 | 11.1 | 25.9 |

(Source: Szabó, 2002)

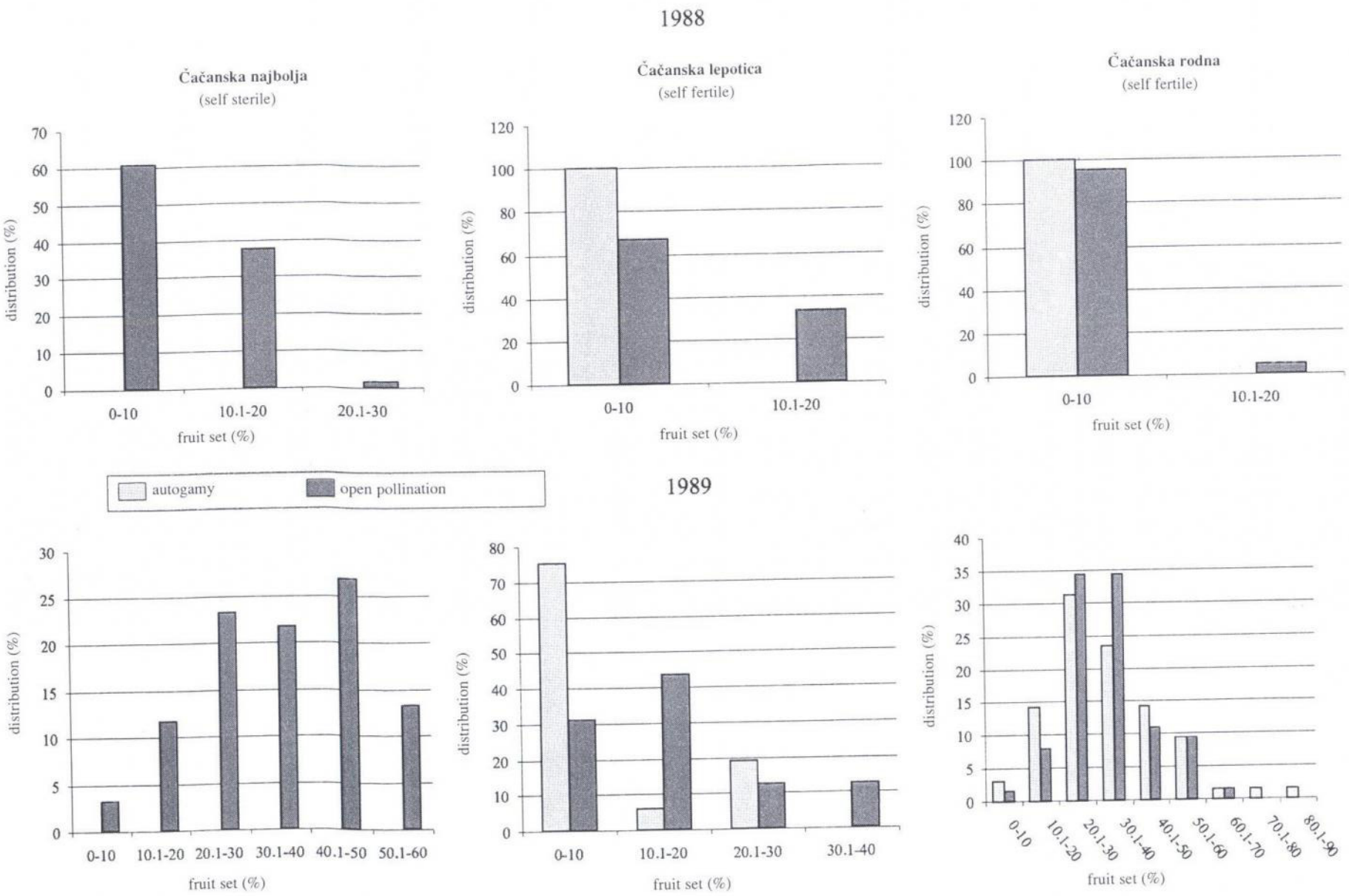


*Figure 1* Distribution of fruit sets by autogamy and by open pollination (%) (Sousce: Szabó, 2002)

***Table 3*** Number of replications

| Treatment | Number of branches | | | Number of trees | | |
|---|---|---|---|---|---|---|
| | minimum | maximum | mean | minimum | maximum | mean |
| Autogamy | 1 | 44 | 13 | 1 | 17 | 4 |
| Open pollination | 3 | 45 | 17 | 1 | 17 | 8 |

(Source: Szabó, 2002)

display the same tendency, i.e. fertility experienced by autogamy as well as after open pollination varied yearly, but the variance of the latter was smaller than that of the former, i.e. auto-fertility of varieties is more unstable than cross-fertility. Conditions of fruit set have been classified by *Nyéki* (1980). The high variation of fruit set in the same variety between years was partly due to different methods, but in some cases to the variable sample sizes. In order to standardise the sample size, the variation of fruit set at Ráckeve has been analysed according to branches as well as to individual trees. Each variety and season has been represented by 4–16 trees, at the cardinal directions (N, W, S, E), 1.5–2 m high above the soil, branches were isolated (each 25 flowers as a mean) or alternatively counted and tagged to seize fruit set after open pollination (80 flowers as a mean). Fruit set varied between wide limits in auto-pollinated as well as in open pollinated flowers *(Table 2)*. All varieties produced isolated branches without any fruit set. At three varieties, except *Stanley*, in single cases also the open pollinated branches remained bare. Multiple differences have been experienced also between trees in fruit set caused by autogamy as well as by open pollination. The large differences are attributed to different effects as experimental error, injury of the branches due to cultivation, wind, frost around the blooming period, weakness of the branch or of the tree, disease caused by *Monilia* (in flowers of sour cherry, plum or apricot), insect feeding, etc.

In *Figure 1*, data of fruit set have been compared in isolated as well as in open pollinated branches during an unfavourable (1988) and a favourable season (1989). Around blooming cold weather prevailed in 1988, three nights were even frosty (below 0 °C). Consequently, the rate of fruit set was low in all treatments. On trees of *Čačanska rodna* almost all branches (95.3%) displayed low (<10%) fruit set. It means the cold-sensibility of the flowers. In the next year the maximum temperature was between 15 and 20 °C during the blooming period, besides the bees were very active. The year 1989 displayed approximately the potentialities of fruit set of varieties. The auto-incompatible variety *Čačanska najbolja* proved to be more fertile than the partially self-fertile variety *Čačanska lepotica*. The lower self-fertility of the latter variety was proved by the fact that fruit set in three quarter of isolated branches was less than 10%.

Fruit set of *Čačanska rodna* produced very variable fruit sets in isolated as well as on freely blooming branches. Most of the tagged, open pollinated branches set fruit between 20 and 40%. The wide range of variation may indicate further possibilities in improving fruit set by varying conditions.

Earlier suggestions concerning sample size and position of branches are less precise and seem to be content with a lower number of samples. *Rudloff & Schanderl* (1950) recommended 100–200 flowers to be pollinated in order to get reliable results. Nyéki (1974) mentioned 8–10 isolators (containing at least 100 flowers) to each cross-combination, as necessary for obtaining definitive results as cross-compatibility is concerned.

*Palara* et al. (1990) explored the statistically necessary conditions to determine self-fertility, cross-compatibility and free pollination of Japanese plums. Ten branches per variety and per treatment, i.e. 60 flowers were assigned to each treatment.

Fruit set data of the four plum varieties over three years served to establish standards of the number of replications statistically justified (according to *Sváb*, 1981) as presented in *Table 3*. The probability level of 5% and a 5% error of estimation have been calculated to achieve a reasonable number of replicates. On the basis of our calculations, 20 branches are claimed per variety (or per combination), which should be distributed on 5 (for autogamy) and 10 (for open pollination) trees, respectively. The validity of judgements is improved considerably by the higher number of flowers per sampled branches (i.e. at least 20 flowers per isolator or 50 flowers per tagged branches for free pollination).

Branches are to be selected on the 4 cardinal points of the crown at 1.5–2 m height above ground. Fruit set of individual varieties is compared accurately. However, varieties are comparable at least over three years only.

Our results are though referring to European plums, but other fruit species with different flower densities and rates of fruit set may also considered applying the same method with due modifications.

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